

POPULATIONS AT RISK

Is Food Insufficiency Associated with Health Status and Health Care Utilization Among Adults with Diabetes?

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OBJECTIVES: Preliminary studies have shown that among adults with diabetes, food insufficiency has adverse health consequences, including hypoglycemic episodes and increased need for health care services. The purpose of this study was to determine the prevalence of food insufficiency and to describe the association of food insufficiency with health status and health care utilization in a national sample of adults with diabetes.

METHODS: We analyzed data from adults with diabetes ($n = 1,503$) interviewed in the Third National Health and Nutrition Examination Survey. Bivariate and multivariate analyses were used to examine the relationship of food insufficiency to self-reported health status and health care utilization.

RESULTS: Six percent of adults with diabetes reported food insufficiency, representing more than 568,600 persons nationally (95% confidence interval, 368,400 to 768,800). Food insufficiency was more common among those with incomes below the federal poverty level (17% vs 4%, $P \leq .001$). Adults with diabetes who were food insufficient were more likely to report fair or poor health status than those who were not (63% vs 43%; odds ratio, 2.2; $P = .05$). In a multivariate analysis, fair or poor health status was independently associated with poverty, nonwhite race, low educational achievement, and number of chronic diseases, but not with food insufficiency. Diabetic adults who were food insufficient reported more physician encounters, either in clinic or by phone, than those who were food secure (12 vs 7, $P < .05$). In a multivariate linear regression, food insufficiency remained independently associated with increased physician utilization among adults with diabetes. There was no association between food insufficiency and hospitalization in bivariate analysis.

CONCLUSIONS: Food insufficiency is relatively common among low-income adults with diabetes and was associated with higher physician utilization.

KEY WORDS: food insufficiency; diabetes; health status. *J GEN INTERN MED* 2001;16:404–411.

Despite the economic prosperity of the United States, 38 million Americans still live at or below the poverty level¹ and are at risk of experiencing food shortages and hunger.^{2,3} Food insufficiency is a concept closely related to hunger, the physical sensation caused by a lack of food,⁴ and refers to an inadequate intake due to lack of financial resources.⁵ Those who report not having enough food to eat or who have to cut down on the size of meals or skip meals because of financial constraints are considered food insufficient.

Until recently, there were limited national data on the presence of hunger and food insufficiency in the United States.^{2,6,7} Rates of food insufficiency from the Third National Health and Nutrition Examination Survey (NHANES III) were estimated to be approximately 4% in the general population and 14% in a low-income subset.⁸ Other studies of high-risk populations report rates of food insecurity and hunger as high as 25% to 80%.^{9–11}

Chronic hunger over an extended time period may lead to malnutrition and disease,^{12–18} but the health impact of food insufficiency is not well described.¹⁹ Recent studies in children suggest a connection between episodic food deprivation and adverse health outcomes, including low weight-for-age and increased psychosocial problems, before the development of overt malnutrition.^{20–22} Adults experiencing food insufficiency may have to make trade-offs between food and medication, leading to increased use of health services.^{23,24}

Because dietary regulation and meal planning play a fundamental role in disease management,²⁵ adults with diabetes may be especially susceptible to the effects of food insufficiency. In a study of patients with insulin-dependent diabetes from an urban county hospital, one third of hypoglycemic episodes were attributed to not being able to afford food.¹⁰ One quarter of these episodes resulted in patients seeking additional medical care. A case series of community-dwelling elderly also reported problems with diabetic management related to food inadequacy and hunger.²⁶

These studies suggest that adults with diabetes who experience episodic hunger may have worsening disease control and require more health services. However, small sample sizes limit their generalizability to larger populations

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of adults with diabetes. We analyzed data from NHANES III drawn from a national probability sample to address the following questions: (1) What is the prevalence of food insufficiency in a national sample of adults with diabetes? (2) Is food insufficiency associated with poorer health status in patients with diabetes? and (3) Is food insufficiency associated with higher health services utilization by individuals with diabetes? These findings have policy implications for funding health and nutrition programs to this population, especially given recent welfare reform efforts.

METHODS

NHANES III was conducted by the National Center for Health Statistics at 89 survey locations between 1988 and 1994.²⁷⁻²⁹ The survey is a cross-sectional nationally representative sample of the noninstitutionalized U.S. civilian population aged 2 months and older. NHANES III used a stratified, multistage probability cluster design with oversampling of Mexican Americans, African Americans, and persons aged more than 60 years. The survey consisted of multiple components: a household interview, a physical examination conducted in a mobile center, and laboratory tests. Descriptions of the standardized protocols used for all interview and examinations have been previously published.³⁰

A total of 18,825 people over 20 years of age completed the household survey (81% of all eligible individuals). Seven percent of the adults sampled ($n = 1,503$) reported having been told by a physician that they had diabetes³¹ and comprise the study population for this analysis. Based on previous studies that demonstrate self-reported diagnosis is valid and reliable,³²⁻³⁵ we believe this sample accurately represents a national population of adults with diabetes.

DEPENDENT VARIABLES

The dependent variables of interest for this analysis are self-reported health status and health care utilization. Survey respondents were asked: "In general, would you consider your health excellent, very good, good, fair, or poor?" This question has been shown to be predictive of mortality and future health status in numerous studies, independent of other physiological, behavioral, and psychological risk factors.³⁶⁻³⁸ Global health status is analyzed as a dichotomous variable, comparing fair or poor health status to good, very good, or excellent health status.³⁹

Health service utilization variables include both the rates of reported hospitalizations and the number of physician encounters, either clinic visits or phone contacts during the previous year. Respondents were asked: "During the past 12 months, how many times did you see or talk to a medical doctor or assistant?" Clinic visits could not be disaggregated from phone contacts in the NHANES data set. The number reported will be referred to as "physician encounters."

Independent Variables

Food Insufficiency. Two food sufficiency questions from NHANES III correspond closely with the concept of hunger and pertain to self-reported quantity of food.^{2,40,41} Respondents were asked to describe the food eaten in general by their family as "enough food to eat," "sometimes not enough food to eat," or "often not enough food to eat." This indicator has been used by the U.S. Department of Agriculture since the mid-1970s to measure food deprivation⁴² and has been demonstrated to be associated with food expenditures and nutrient intake.^{43,44} This single item has undergone cognitive testing and has been shown to have face validity, in that survey respondents understood the question and could respond easily to it.^{45,46} During the second phase of NHANES III, respondents were asked if, during the previous month, adults in the family had to cut down on the size of meals because of financial constraints. These items were asked as part of the family questionnaire and population estimates for food insufficiency experienced by an individual are based on reports about food sufficiency at the household level. For this analysis, respondents were classified as food insufficient if they reported that they "sometimes" or "often" did not get enough to eat because of inadequate financial resources or if they reported having to cut down on the size of meals because of financial constraints.

Sociodemographic and Other Control Variables. Sociodemographic variables included age, gender, race/ethnicity, and education. Self-reported race and ethnicity information was used to classify persons as non-Hispanic white, non-Hispanic black, Mexican American, or other. Age was determined at the time of interview.

Social resources such as income, health care coverage, and a regular source of medical care were ascertained. During the screening and family interview, a responsible adult provided information about each family member with regard to family income and health care coverage. Income was reported at the household level for the previous twelve months. This income was used to determine a poverty index ratio (PIR), the ratio of the family income to the federal poverty level, multiplied by 100. The PIR was corrected for the number of family members and the year of survey completion. For this analysis, four income categories were created: less than 100% of the federal poverty level, 100% to 200% of the federal poverty level, 200% to 300% of the federal poverty level, and more than 300% of the federal poverty level. Participation in the food stamp program was also determined for the year prior to survey completion. Community variables such as level of urbanization and region of residence in the United States were also used.

Health coverage categories included private insurance, Medicare, Medicaid, dual coverage with Medicare and Medicaid, and no insurance. Because of the small numbers ($n = 25$), respondents covered exclusively by the Veteran

Affairs administration were excluded from multivariate analysis.

Health-related variables included measures of disease control, body mass index,⁴⁷ and current tobacco use.⁴⁸ Self-reported treatment with insulin, oral hypoglycemic medications, or diet was also analyzed. We did not analyze type I diabetes as a separate category given the small sample size. Comorbid illness was assessed by the number of chronic illnesses. For number of self-reported chronic diseases,⁴⁹ respondents were asked: "Has your doctor ever told you that you have...(list of illnesses presented to respondents)?" Glycosylated hemoglobin, a laboratory test that reflects blood sugar control over the previous 3 months,⁵⁰ was utilized as a physiologic measure of disease control. The American Diabetes Association guidelines were used as criteria for glycemic control; glycosylated hemoglobin cut-points analyzed included both 7%, considered the goal value for diabetic adults, and 8%, where additional action or a new treatment plan should be undertaken.⁵¹

Statistical Analysis

Data were weighted to account for the unequal probability of selection that resulted from the survey cluster design, nonresponse, and oversampling of certain target populations.^{29,52} Statistical analysis was performed using STATA 5.0 software (Stata Corp., College Station, Tex) to take into account the complex sampling strategy. Sampling weights provided in NHANES III were used to calculate population estimates, and sampling strata and primary sampling units were used to estimate variances and test for significant differences. All tables are presented using unweighted counts (*n*) and weighted estimates.

Bivariate analysis was performed to assess significant associations between food insufficiency and the dependent variables (self-reported health status, hospitalization, and number of physician encounters). Two logistic regression models were constructed to evaluate the association of age, race, gender, education, income, and food stamps with food insufficiency.

Multivariate models were constructed to examine the association of food insufficiency with several sets of variables: (1) sociodemographic factors, including age, race, gender, and education; (2) social resources, including income, health care coverage, and having a regular source of medical care; and (3) measures of disease control, insulin use, and the number of other chronic illnesses. Regression models were constructed to assess the independent association of food insufficiency with self-reported health status and number of physician encounters during the previous year using variables with significant association ($P < .05$) in bivariate analysis. Multicollinearity was assessed using correlation coefficients between the independent variables. None of these coefficients was more than 0.6.

RESULTS

Characteristics of the study population are displayed in Table 1. Weighted estimates of percentages or means and their standard errors are presented. Six percent of the sample reported food insufficiency, and 13% had received food stamps in the previous year. Only 4% of this sample reported excellent health. More than 40% of the sample reported either fair or poor health. The mean number of physician encounters, both clinic visits and phone calls, for the previous year was more than 7. More than one quarter had been hospitalized in the prior year.

Table 2 displays the relationship of previously identified sociodemographic factors⁸ and food insufficiency. Those who were nonwhite, less well-educated, or poor, or had received food stamps reported higher rates of food insufficiency. In multiple logistic regression, being

Table 1. Characteristics of Adults with Diabetes in NHANES III (*n* = 1,503)

	<i>n</i>	Value	SE
Independent variables			
Food insufficient, %	131	6	1
Food stamp recipient, %*	283	13	1
Mean age, y	1,503	64	14
Female, %	845	55	2
Race, %			
White	598	75	2
African American	418	15	1
Mexican American	450	6	0.4
Other race	37	5	1
Less than high school education, %	927	43	3
Income <100% of poverty, %†	387	18	2
Urban, %	667	44	4
Health insurance, %			
Private Insurance	362	37	2
Medicare	663	37	2
Medicare and Medicaid	185	8	1
Medicaid	94	5	1
Uninsured	119	7	1
Regular source of care, %	1,419	96	1
Obese, %‡	539	44	2
Current tobacco use, %	244	18	2
Insulin use, %	478	30	2
HgbA1c, %§	563	38	2
Mean no. of chronic illnesses	1,503	2.4	1.9
Dependent variables			
Health status, %			
Excellent	48	4	1
Very Good	157	15	2
Good	455	36	2
Fair	576	30	2
Poor	270	14	1
Mean no. of physician encounters*	1,477	7.7	0.3
Hospitalized in the past year, %	427	27	1
Mean no. of hospitalizations*	1,493	1.7	0.1

Means, percentages, and standard errors (SEs) are weighted values.

* During the previous year.

† Income data available for *n* = 1303.

‡ Body mass index >30 kg/m².

§ HgbA1c indicates % glycosylated hemoglobin, data available for *n* = 1,281.

Table 2. Relationship of Sociodemographic Characteristics to Food Insufficiency

	Experiencing Food Insufficiency, % (n = 1,503)	Unadjusted OR (n = 1,503)	Adjusted OR	
			Model 1 (n = 1,303)	Model 2 (n = 1,303)
Age, y	NS	1.0	1.0	1.0
Female	NS	1.1	0.9	0.5
Race				
White	4	1.0	1.0	1.0
African American	8	2.2*	1.2	1.2
Mexican American	20	6.5 [†]	4.2 [†]	4.1 [†]
Other	27 [‡]	9.6 [‡]	10.5 [‡]	9.5 [‡]
Education				
Less than high school	9	3.3*	1.4	1.2
High school	5	1.6	1.4	1.2
More than high school	3*	1.0	1.0	1.0
Income, % poverty level [§]				
<100	17	19.2 [†]	16.1 [†]	10.5*
100–200	9	9.7*	9.4*	8.5*
200–300	1	0.9	0.8	0.8
>300	1 [‡]	1.0	1.0	1.0
Food stamp recipient				
Yes	20	5.5 [‡]	—	2.3*
No	4 [‡]	1.0	—	1.0

* $P \leq .05$.[†] $P \leq .01$.[‡] $P \leq .001$.[§] Income data available for n = 1,303.

OR indicates odds ratio; NS, not significant.

Mexican American or “other” race, or poor were significantly associated with food insufficiency (Model 1). When food stamp recipient status was controlled for (Model 2), the association of poverty to food insufficiency is diminished. Tobacco use, region of the country, urban or rural residence, and number of chronic diseases were not significantly associated with food insufficiency in bivariate analysis (data not shown).

Table 3 displays the association of food insufficiency with self-reported fair and poor health. Those reporting food insufficiency were more likely to report fair or poor health compared with those who were not (63% vs 43%, $P = .05$; odds ratio, 2.2). More than 70% of those living under the poverty line reported fair or poor health compared with only one quarter of those with incomes 3 times the poverty level (71% vs 26%, $P < .001$). Mexican Americans and African Americans were much more likely to report fair or poor health compared with whites. Reporting fair or poor health status was not significantly associated with region of the country, tobacco use, having a regular source of care, urban residence, or obesity in bivariate analysis (data not shown). In logistic regression models of fair or poor health status, income explained the relationship between food insufficiency and health status. In the full model, poverty, nonwhite race, low education level, increasing number of comorbid diseases, and insulin use were associated with fair and poor health.

Adults with diabetes who reported food insufficiency had significantly more physician encounters in the previous year than those who did not experience food

insufficiency (12 vs 7, $P < .05$). Table 4 displays other significant associations with physician encounters in bivariate analyses including female gender, poverty, health care coverage, number of chronic diseases, better glucose control, insulin use, fair or poor health status, having a regular source of care, and urban residence. Physician utilization was not associated with age, race, education, or obesity in bivariate analyses (data not shown). Staged linear regression was performed using these control variables to determine the independent association of food insufficiency with the number of physician encounters during the previous year (Table 4). In Model 1, food insufficiency remained significantly associated with higher physician utilization after controlling for age, gender, race, and education. The effect of poverty was reduced after controlling for food insufficiency, age, and gender (Model 2). The effect of dual Medicare and Medicaid coverage was attenuated by an increasing burden of disease and worsening health status (Model 3). There was no significant association between food insufficiency and hospitalization (data not shown).

DISCUSSION

The primary aim of this study was to determine the prevalence of food insufficiency in a national sample of adults with diabetes and to understand the potential health effects of episodic hunger in this population. Six percent of diabetic adults reported problems with food insufficiency related to financial constraints, representing over 568,000

Table 3. Relationship of Food Insufficiency to Fair and Poor Health Status, Logistic Regression

	Unadjusted OR (n = 1,503)	OR	
		Limited (n = 1,303)	Full (n = 1,281)
Food insufficient	2.2*	1.1	0.9
Income, % poverty level [§]			
<100	7.3 [‡]	7.2 [‡]	3.5 [‡]
100–200	2.7 [‡]	2.7 [‡]	1.5
200–300	2.3 [‡]	2.3 [‡]	1.6
>300	1.0	1.0	1.0
Race			
White	1.0	—	1.0
African American	2.0 [‡]	—	1.9 [‡]
Mexican American	2.5 [‡]	—	2.3 [‡]
Other	0.5	—	1.4
Age, y	1.01*	—	1.0
Female	1.8 [†]	—	1.0
Education			
Less than high school	2.0*	—	2.0*
High school	0.9	—	1.7*
More than high school	1.0	—	1.0
Insurance			
Private	1.0	—	1.0
Medicaid	1.9	—	1.1
Medicare	1.1	—	0.8
Medicare and Medicaid	5.6 [‡]	—	2.1
No insurance	2.1*	—	1.6
Regular source of care	1.0	—	1.0
Health status			
No. of chronic illnesses	1.3 [‡]	—	1.3 [‡]
HbA1c <8%	0.7*	—	0.6*
Insulin use	1.9 [‡]	—	1.7*

* $P \leq .05$.† $P \leq .01$.‡ $P \leq .001$.

§ Income data available for n = 1,303.

The comparison group were those who reported good, very good, or excellent health status. OR indicates odds ratio.

persons nationally (National estimate: 568,623 [95% CI 368,435; 768,812]). Food insufficiency was much more common among low-income groups, affecting almost one fifth of those with annual incomes under the federal poverty level. We found that food insufficiency was associated with fair or poor health status and increased physician utilization among adults with diabetes. The association of food insufficiency and health status was explained in multivariate analysis by known predictors of fair or poor health status,^{53–55} including poverty, low educational achievement, and nonwhite race.

The main limitation to this study is that its cross-sectional nature does not allow drawing causal inferences. Less significant limitations include the sampling frame and survey methodology used in NHANES III. The survey is representative of noninstitutionalized U.S. citizens and does not include the homeless, a population perhaps at the highest risk for poor health and food insufficiency.^{56,57} The utilization measures are self-reported and may be subject to response bias. In addition, physician utilization was measured by a single item that assessed the combined number of clinic visits and phone calls. Our physician encounter findings are slightly higher than observed in

the National Health Interview Survey (>7 vs 4 per year),⁵⁸ probably because in the present study, the variable included both clinic visits and telephone contacts. Because clinic and phone calls could not be disaggregated, the absolute estimates about physician utilization may be exaggerated.

Food insufficiency may have health consequences for adults with diabetes that were not measured by this study, including immediate effects on blood sugar and the ability to adhere to a diabetic diet. Adults with diabetes who are food insufficient have been noted to experience worsening blood sugar control, both from hypoglycemic reactions while taking insulin or hyperglycemia if they stop their insulin to avoid insulin reactions.¹⁰ The majority of diabetic patients from NHANES III had type II diabetes, which is largely linked to obesity. Although caloric restriction is the cornerstone of treatment for type II diabetes, food insufficiency may actually impact on the ability to adhere to a nutritionally adequate diet. Food insufficiency has been related to poor quality diets, including lower consumption of fruits and vegetables and low intakes of essential nutrients.^{42,43} Adults with diabetes in general report low dietary compliance,^{25,59} and those with low incomes may

Table 4. Relationship of Food Insufficiency to Number of Physician Encounters, Staged Linear Regression

	Unadjusted β (n = 1,503)	Adjusted β		
		Model 1 (n = 1,469)	Model 2 (n = 1,283)	Model 3 (n = 1,152)
Food insufficient	5.2*	5.1*	4.3*	3.7*
Age, y	0.04	0.04	-0.02	-0.06
Female	2.4 [†]	2.3 [‡]	1.9 [‡]	1.1*
Race				
White	0.0	0.0	0.0	0.0
African American	0.1	-0.2	-0.7	-0.6
Mexican American	-0.6	-1.4	-1.1	-0.5
Other	2.4	1.0	1.5	1.2
Education				
Less than high school	1.0	0.5	-0.03	0.3
High school	-0.2	0.3	0.1	0.4
More than high school	0.0	0.0	0.0	0.0
Income, % poverty level				
<100	2.5*	—	0.8	-0.6
100-200	1.0	—	0.2	-0.1
200-300	-1.6 [†]	—	-0.6	-1.0
>300	0.0	—	0.0	0.0
Insurance				
Private	0.0	—	0.0	0.0
Medicaid	2.1	—	0.9	0.6
Medicare	0.3	—	1.6	0.5
Medicaid and Medicare	5.9 [‡]	—	5.0 [‡]	4.3*
No insurance	0.4	—	0.9	0.9
Health status				
No. of chronic illnesses	1.05 [‡]	—	—	0.9 [‡]
HbA1c <8%	1.6*	—	—	1.3*
Insulin use	1.4*	—	—	1.3*
Fair or poor health status	3.5 [‡]	—	—	2.1 [†]
Regular source of care	4.2 [‡]	—	—	3.1 [†]
Urban	1.6 [†]	—	—	1.2

* $P \leq .05$.[†] $P \leq .01$.[‡] $P \leq .001$.

Physician utilization is an aggregate of physician visits and phone calls during the previous year.

Adjusted β represent excess physician encounters attributed to each independent variable.

have more difficulty following a diabetic diet due to financial constraints.^{60,61} The relationship between food insufficiency and dietary adherence, especially among low-income diabetic adults, warrants further study.

Although NHANES III has no direct measure of hypoglycemic episodes, increased physician encounters experienced by food insufficient diabetics could reflect greater problems with disease management. Our data suggest that independent of disease severity and comorbid illness, an adult with diabetes who is food insufficient makes, on average, 3 more physician phone calls or clinic visits per year. Diabetes affects over 5% of the U.S. population³¹ with direct medical costs exceeding \$7.7 billion per year.⁶⁴ One quarter of these expenses are attributed to outpatient care, with an average office visit charge of more than \$100.⁶² If food insufficiency leads to problems with disease management and increased physician utilization, it may be more cost-effective to ensure food security to this population than to provide additional medical services. Increased physician utilization could also reflect greater disease severity or other patient needs that were not measured in NHANES III. A prospective study of

the impact of food insufficiency on health care utilization would provide useful information for policy makers regarding funding for health and nutrition programs to the diabetic population and is critically important given the recent changes in welfare policy.

Almost one half of the cost savings of recent welfare reform legislation came from cuts to food and nutrition programs,⁶³ and food stamp allotments have been uniformly decreased.^{64,65} Approximately 13% of diabetic adults in this sample reported obtaining food stamps, representing an estimated 1.2 million individuals nationally (National estimate 1,194,866 [95% CI 954,815; 1,434,958]). Almost one quarter of the diabetic adults who received food stamps in the previous year reported food insufficiency, compared with only 4% of those without food aid. This result is consistent with previous studies^{5,66} and highlights the importance of food aid programs to vulnerable populations. Reductions in food stamps have already been associated with increased rates of hunger^{10,67} and food assistance programs have been demonstrated to decrease rates of hunger and hospitalizations in the elderly with diabetes.⁶⁸ Rates of

food insufficiency in former program participants, as well as lower health status and higher health care utilization in the diabetic population, may be important measures of the effect of welfare reform.

Karin Nelson was a NRSA research fellow in the Division of General Medicine at UCLA when this study was conducted. Lillian Gelberg is a Robert Wood Johnson Foundation Generalist Physician Faculty Scholar. William Cunningham is a Doris Duke Charitable Foundation Clinical Scientist.

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